Digital Infrastructure Construction and Urban-Rural Income Gap: A Quasi-Natural Experiment Based on the "Broadband China" Strategy

Huan Wang

Sichuan Agricultural University, Dujiangyan, Chengdu, 624014, China

1600454590@qq.com

Abstract. Based on the panel data of 283 cities in China from 2010 to 2022, this paper explores the impact of digital infrastructure construction (GT) on the urban-rural income gap (Theil) by using the multi-stage different-in-differences model (DID). The empirical results show that digital infrastructure construction will widen the urban-rural income Inequality, and the results are still valid after a series of robustness tests. Further research shows that the level of human capital plays a moderating effect on the impact of digital infrastructure on urban-rural income gap.

Keywords: digital infrastructure, "broadband China" policy, urban-rural income gap.

1 Introduction

Broadband digital technology is gradually linked with all kinds of economic activities and innovation activities more and more closely, many countries have taken the quality improvement and diffusion of broadband network as a national development strategy, in order to master the initiative of information technology development. In recent years, China has made remarkable achievements in digital technology. With the continuous improvement and upgrading of digital infrastructure, it has reached the world's leading level in many aspects. However, due to the restrictions of China's special urban-rural dual structure, it is still controversial what effect network infrastructure plays on the coordinated development of urban and rural income.

The literature closely related to this study mainly focuses on two aspects. First, some scholars have found that digital infrastructure is an important way to alleviate income inequality from the perspectives of information infrastructure and electronic products[1]. Second, some scholars have demonstrated the inverse "U" relationship between digital infrastructure construction and income inequality from the perspectives of digital economy and broadband coverage[2,3]. At present, there are still great differences in the construction of digital network on income inequality. Based on China's special policy background and social environment, this study will explore the relationship between digital

S. M. Zabri et al. (eds.), *Proceedings of the 2025 4th International Conference on Big Data Economy and Digital Management (BDEDM 2025)*, Advances in Intelligent Systems Research 191,
https://doi.org/10.2991/978-94-6463-710-6_22

infrastructure and urban and rural development, and answer the question of what role it plays in income inequality.

2 Theoretical Analysis and Research Hypothesis

The increase in frequency and depth of Internet use creates more opportunities for higher income, but in many important conditions, rural areas are at a disadvantage compared with urban areas. On the one hand, rural residents are often limited by their own abilities and external resources, and their sense of opportunity is often delayed. Coupled with the uneven distribution of digital infrastructure construction in urban and rural areas and the shortage of talents, rural areas are more difficult to construct and transform results than urban areas, which has laid a huge hidden danger for exacerbating the inequality of urban and rural information construction. On the other hand, due to the paid use of broadband network, in view of the relative shortage of available resources in rural areas, household income sources and income levels are not as good as those in urban areas, and residents' willingness to bear the same broadband costs is often lower than that of urban residents in the case of low disposable income, which will further expand the economic differences between rural and urban residents in income, consumption and employment[4]. Some scholars have expressed concern that broadband networks may exacerbate urban-rural income inequality. Therefore, the first hypothesis of this study is that the construction of digital infrastructure expands the urban-rural income inequality.

Human capital is an important basis for technology absorption, knowledge diffusion and benefit output, and provides a necessary soft environment for the development of digital technology[5]. At the same time, the benefit output of new digital infrastructure is often accompanied by the expansion of the demand for human capital with high professional and technical ability, and the development of rural digital technology also needs young, dynamic and creative human capital. However, due to the differences in the radiation range of siphon effect in regions with different development levels, conditions are created for human capital to produce Matthew effect in urban and rural areas. Most people with higher education level will choose to go to cities to seek development opportunities, which also leaves hidden dangers for the coordinated and sustainable development of urban and rural areas[6]. So our hypothesis 2 is that the difference in human capital level may play a role in the impact effect of digital infrastructure on urban and rural income.

3 Research Design

3.1 Model Construction

This paper regards the construction of "Broadband China" demonstration cities as a policy impact external to the urban-rural income gap, and as a quasi-natural experiment. In view of the fact that the selected "Broadband China" demonstration cities selected in batches, the following multi-phase DID model is constructed in this paper:

$$Theil_{it}=\alpha_0+\alpha_1 GT_{it}+\alpha_2 control_{it}+\mu_i+v_t+\varepsilon_{it} \quad (1)$$

i represents city; t represents year; Theil represents the income gap between urban and rural areas; GT is a binary variable indicating whether a city is selected as a demonstration city for the "Broadband China" initiative; control is a set of control variables; μ_i and v_t represent individual and time fixed effects; ε_{it} is a random disturbance term.

3.2 Measurement and Description of Variables

Explained variable: The Theil index is used in this study to measure the urban-rural income gap (*Theil*), and the calculation method for the following type 2:

$$Theil=\sum_{i=1}^{2}\left(I_{i,t}/I_t\right) \times \ln(\left(\frac{I_{i,t}}{I_t}\right)/(\frac{H_{i,t}}{H_t})) \quad (2)$$

i equals 1 and 2 for town and country respectively; $I_{i,t}$And $H_{i,t}$ represent the total disposable income and population of urban or rural residents in the t year.

Explanatory variable: "Broadband China" demonstration city (GT), obtained by assigning virtual variable to whether it is selected as "Broadband China" demonstration city.

Control variable: urbanization level (Urban), expressed by the ratio of the total number of permanent urban residents to the total number of permanent urban residents. The level of economic development (lnrgdp) is expressed using the logarithm of GDP per capita. Industrial structure upgrading (industry) is expressed by the ratio of the third and the second output value. Education expenditure level (edu), expressed as the ratio of education expenditure to general public budget expenditure. Level of Government intervention (gov), expressed using the ratio of general public budget expenditure to gross public product.

4 Empirical Analysis

4.1 Parallel Trend Test

Satisfying the parallel trend hypothesis is a necessary prerequisite for using the DID model, that is, significant changes will occur before and after the implementation of the policy. We construct Model (3) to test parallel trends.

$$Y_{it}=\theta_0+\theta_1 XH_{it}^{-5}+\theta_2 XH_{it}^{-4}+\cdots+\theta_{14} XH_{it}^{8}+\theta control_{it}+\mu_i+v_t+\varepsilon_{it} \quad (3)$$

XH_{it}^{-n} and XH_{it}^{n} represents the virtual variables of city i in the n year before or the n year after being selected as pilot city, respectively. Since the policy is announced one year in advance, this paper takes the year before the selection of "Broadband China" demonstration cities as the base period year.

The results of test are shown in figure 1 below. The horizontal axis is relative time of the policy, and the vertical axis is impact coefficient brought by the policy. It can be seen that as time goes by, the impact of the "broadband China" strategy on the urban-rural income Inequality has gradually increased. Therefore, the parallel trend test results of this study pass.

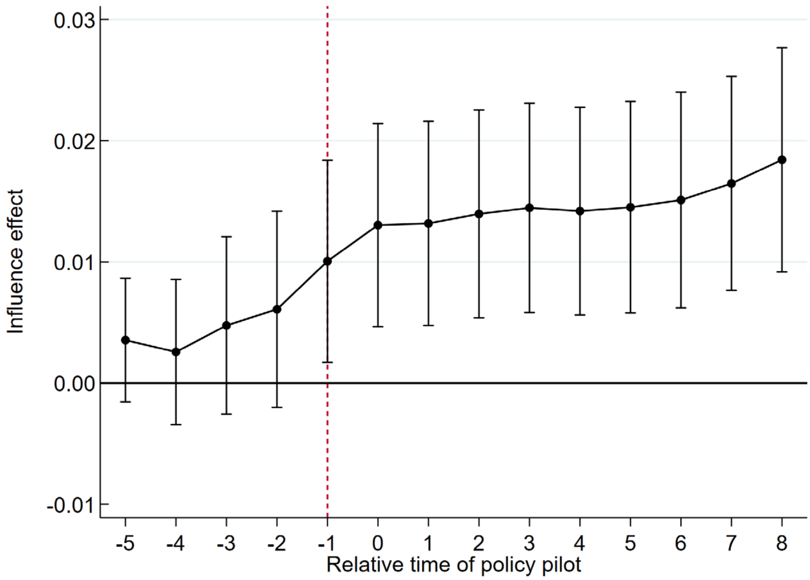

Fig. 1. Parallel trend test

4.2 Baseline Regression

Table 1 (1) is only the regression result of "Broadband China" policy (GT), and Table 1 (2) is the regression result after adding control variables. It can be seen that regardless of whether control variables are added, it always remains significant at the level of 1%. The above results indicate that the construction of digital infrastructure does play a restraining role in narrowing the urban-rural income gap.

Table 1. Regression results

	(1) Theil	(2) Theil	(3) Theil	(4) GAP	(5) Theil	(6) Theil
GT	0.0096^{***}	0.0087^{***}	0.0085^{***}	0.1033^{***}	0.074^{**}	-0.0046^{**}
	(0.0022)	(0.0018)	(0.0018)	(0.0244)	(0.020)	(0.0022)
capital						-0.1055
						(0.0857)
capital×GT						0.1352^{***}
						(0.0335)
Control	NO	YES	YES	YES	YES	YES
Ind	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
N	3679	3679	3672	3679	3289	3666
R^2	0.916	0.932	0.932	0.907	0.932	0.933

4.3 Further Test Based on PSM-DID Model

The selection of "Broadband China" demonstration cities may not be random. Therefore, this paper adopts a Propensity score matching (PSM) method to further test.The test results based on PSM-DID model are shown in column (3) of Table 1. After controlling for year, individual city and a series of control variables, the estimated coefficient of results are consistent with the benchmark regression results.

4.4 Robustness Test

The first is to replace the core explained variable. This paper uses the ratio of per capita disposable income of urban and rural residents (GAP) to replace the explained variable, and the regression results after replacement are shown in Table 1 (4).The second is to eliminate special samples. The regression results are shown in Table 1 (5) after eliminating the samples of Chinese municipalities and provincial capital cities. It can be seen that the results of this study are relatively robust.

4.5 Adjustment Effect Analysis

$$Theil_{it}=\beta_0+\beta_1 GT_{it}+\beta_2 capital_{it}+\beta_3 capital_{it}\times GT_{it}+\beta_4 control_{it}+\mu_i+v_t+\varepsilon_{it} \tag{4}$$

In the above equation, capital represents the level of human capital, the moderating variable, and the coefficient β_3 of the knowable intersection item in Table 1 (6) is positive and significant, indicating that there is a moderating effect, that is, When the level of human capital is high, digital infrastructure construction will exacerbate the expansion of income inequality.

5 Conclusion

Conclusions: First, digital infrastructure development can widen the urban-rural income inequality, which is still true after using PSM-DID and a series of other robustness tests. Secondly, based on the moderating effect analysis, it is found that in the region with higher human capital level, the expanding effect of network infrastructure on income inequality is stronger.

The policy implications: First, the "broadband China" policy needs to be further implemented, and the problem of unequal access to network technology among different regions should be addressed in the implementation process. For example, rural digital skills training should be carried out to promote digital, finance and e-commerce to take root in rural areas to enhance the added value of rural industries. Second, it is important to further strengthen the effective play of digital infrastructure to increase rural income and restrain the widening of income gap. Among them, it is not only necessary to pay attention to network technology to achieve important breakthroughs in cutting-edge fields, but also to accelerate the sinking of rural network infrastructure and application scenarios, improve the effective integration of new digital infrastructure and rural resources and release more economic benefits. Thirdly, it is necessary to focus on key factors that have an important impact on network infrastructure, such as the level of human capital, to meet the needs of rural human capital and the construction of transportation network, and gradually promote rural areas to share more digital dividends.

References

1. Xu, S., Xu, Z., Guo Z, et al.: Can information infrastructure break the imbalance between urban and rural development? Empirical evidence from China. Information Technology for Development, 1-21 (2024).
2. Patria, H., Erumban, A.: Impact of ICT adoption on inequality. The Journal of Indonesia Sustainable Development Planning 1(2), 125-139 (2020).
3. Ariansyah, K., Barsei, A., Syahr, Z., et al.: Unleashing the potential of mobile broadband: Evidence from Indonesia's underdeveloped regions on its role in reducing income inequality. Telematics and Informatics 82, 102012 (2023).
4. Furuholt, B., Kristiansen, S.: A rural-urban digital divide? Regional aspects of Internet use in Tanzania. The Electronic Journal of Information Systems in Developing Countries 31(1), 1-15 (2007).
5. Caselli, F., Coleman, W.: The world technology frontier. American Economic Review 96(3), 499-522 (2006).
6. Alfaro-Navarro, J L, López-Ruiz V R, et al. Quality of life in the urban context, within the paradigm of digital human capital. Cities 153, 105284(,2024).